BIOASSESSMENT REPORT

RAPID BIOASSESSMENT OF THE

UPPER LAUGHERY CREEK WATERSHED

USING BENTHIC MACROINVERTEBRATES

May 1999

For the
Soil and Water Conservation Districts of
Franklin, Decatur, and Ripley Counties

Study Conducted By:

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EXECUTIVE SUMMARY

A rapid bioassessment technique was used to determine the degree of biological impairment present in Upper Laughery Creek in southeastern Indiana after implementation of various land treatments in the watershed (Project Clear, sponsored by the Historic Hoosier Hills RC&D). The benthic communities of six sites, including a previously established reference site, were sampled during May 1999 to provide information on "after treatment" conditions.

Two of the five study sites in the Upper Laughery Creek watershed had biotic index and habitat values similar to the reference site. These sites showed "no impact." The remaining three sites had lower values, indicative of "slight" to "moderate" imact. The differences were due primarily to degraded habitat rather than water quality.

A previous study of "before treatment" conditions in 1994 found that the average habitat and biotic index scores in the Upper Laughery Creek watershed were 82 for habitat and 72 for biotic index (the highest possible score is 100). The average "after treatment" scores measured at the same sites in this study were 85 for habitat and 79 for biotic index. Both scores indicated that environmental conditions had improved after implementation of land treatments.

The largest improvements occurred in Laughery Creek at CR 200 W in Ripley County, immediately downstream from several watersheds where land treatments had been intensively implemented. The aquatic community at this site improved from "moderately impaired" in 1994 to "no impact" in 1999. Nearly all the metrics used to calculate the biotic index value showed improvement.

INTRODUCTION

This study was conducted to measure the "biological integrity" of Upper Laughery Creek in southeastern, Indiana. The stream is a tributary of the Ohio River and is listed by the Indiana Department of Environmental Management (IDEM) has as having seriously degraded water quality due to nonpoint sources of pollution such as excessive sediment and nutrient inputs from runoff [1].

To deal with this problem, a soil conservation plan (Project Clear) was developed in 1994 by the Franklin, Decatur and Ripley County SWCD offices, with assistance from the Historic Hoosier Hills Resource, Conservation and Development Area. The purpose of the plan was to help reduce nonpoint source problems in the stream.

Prior to implementing the plan, a benthic study of Upper Laughery Creek was conducted to document "before treatment" conditions. This study found that habitat and water quality degradation existed at four sites examined in the watershed. The present study, conducted five years later, was intended to determine whether land treatments in the watershed resulted in improved water quality as reflected by an improved aquatic community.

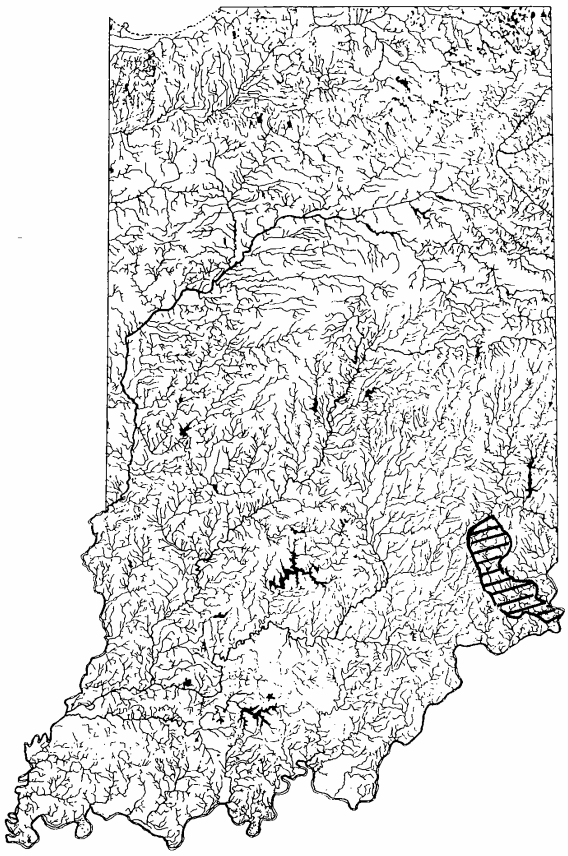
Local Setting

Laughery Creek is located near the border of "Eastern Corn Belt Plain" and "Interior Plateau" ecoregions of the Central U.S. [2]. The land in the Laughery Creek watershed was affected by early glacier activity, but glaciers had less influence here than in more northern areas of the state. This region is sometimes called the "Switzerland Hills" Natural Region of Indiana [14]. The land is characterized by deeply dissected plateaus. Limestone outcrops are common and the soils are typically derived from sedimentary rocks and loess. The original forests were dominated by beech, maple, oak, and hickory trees but row crop agriculture and livestock grazing are the most common land uses today. In fact, about 75% of the watershed is devoted to agricultural uses and about 25% is forested [19]. The Laughery Creek watershed is shown in Fig. 1. The study sites are shown in Fig. 2.

Benthic samples and water quality measurements reported here were collected on May 10, 1999.

Figure 1.

Laughery Creek Watershed

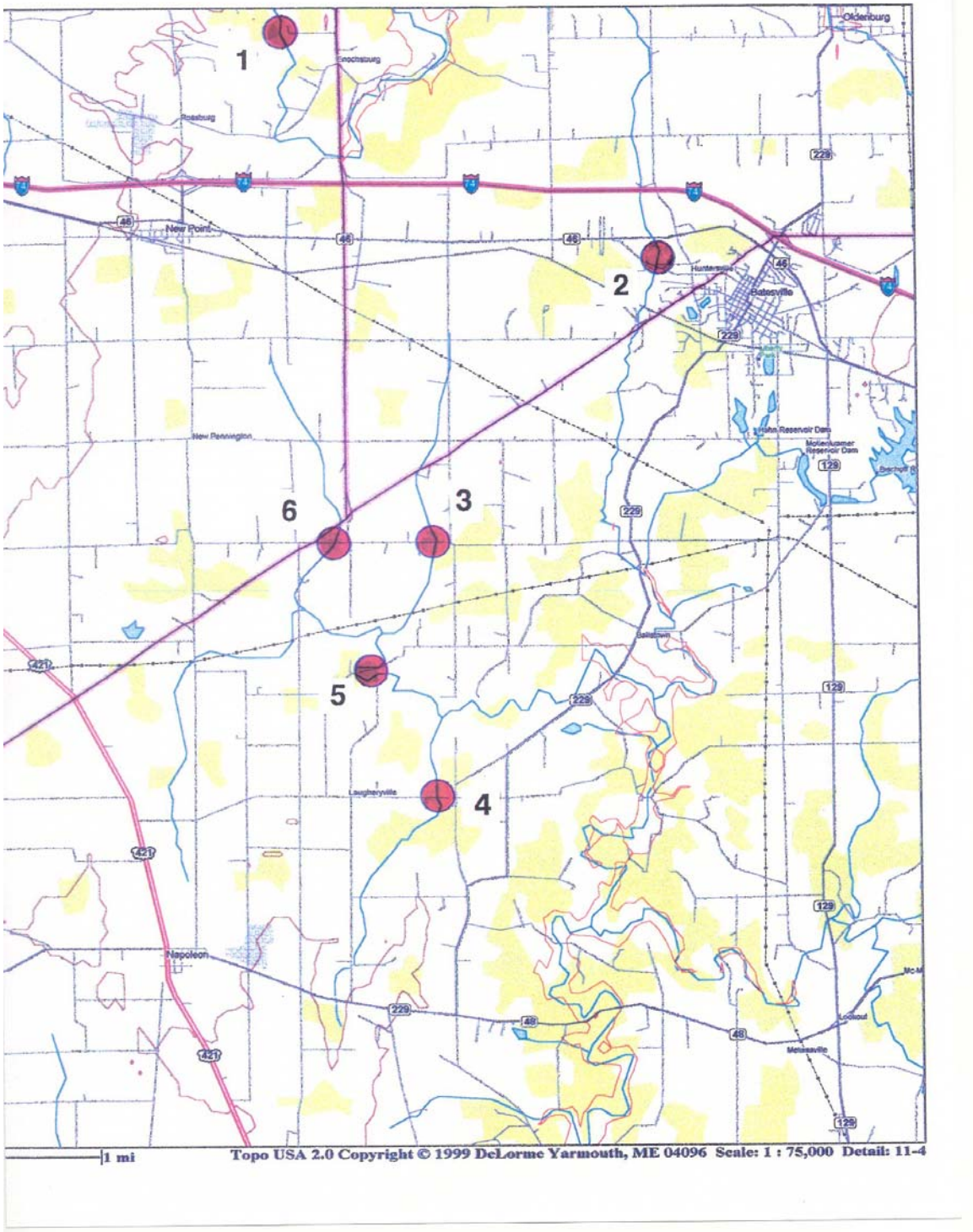


Study sites in the Upper Laughery Creek watershed are small "second to third order" streams. Watershed areas of each site are shown below [18]:

Site 1 Salt Creek @ CR 50 N (reference)	72 km^2 (28 mi^2)
Site 2 Little Laughery Creek @ Hwy 46	38 km^2 (15 mi^2)
Site 3 Walnut Creek @ CR 1300 N	29 km^2 (11 mi^2)
Site 4 Unnamed Tributary @ CR 1050 N	16 km^2 (6 mi^2)
Site 5 Laughery Creek @ CR 200 W	80 km^2 (31 mi^2)
Site 6 Tub Creek @ CR 1300 N	18 km^2 (7 mi^2)

Laughery Creek (Site 5)

Figure 2
Study Sites



METHODS

Because they are considered to be more sensitive to local conditions and respond relatively rapidly to environmental change [3], benthic (bottom-dwelling) organisms were used to document the biological condition of each stream. The U.S. Environmental Protection Agency (EPA) has recently developed a "rapid bioassessment" protocol [4] which has been shown to produce highly reproducible results that accurately reflect changes in water quality. We used EPA's Protocol III to conduct this study. Protocol III requires a standardized collection technique, a standardized subsampling technique, and identification of at least 100 animals from each site to the genus or species level from both "study sites" and a "reference site." CPOM (Coarse Particulate Organic Matter) samples were collected and analyzed to determine the percentage of shredder organisms.

Reference Site

The aquatic community of a reference site is compared to that of each study site to determine how much impact has occurred. The reference site should be in the same "ecoregion" as the study sites and be approximately the same size. It should be as pristine as possible, representing the best conditions possible for that area.

A previous study of the aquatic community of the Whitewater River watershed [5] suggested that Salt Creek had one of the best fish communities and habitat values in the area. Salt Creek in this area has a drainage area which is similar to the study sites and lies only a few miles to the north, in the same ecoregion. Therefore, this site (Site 1) was used as the basis of comparison for all other sites in the study.

Habitat Analysis

Habitat analysis was conducted according to Ohio EPA methods [21]. In this technique, various characteristics of a stream and its watershed are assigned numeric values. All assigned values are added together to obtain a "Qualitative Habitat Evaluation Index." The highest value possible with this habitat assessment technique is 100.

Water Chemistry

Water chemistry measurements were made at each study site on the same day that macroinvertebrate samples were collected. Dissolved oxygen was measured by the membrane electrode method. The pH measurements were made with a Cole-Parmer pH probe. Conductivity was measured with a Hanna Instruments meter. Temperature was measured with a mercury thermometer. All instruments were calibrated in the field prior to measurements.

Macroinvertebrate Sample Collection

Samples in this study were collected by kicknet from riffle habitat where current speed was 20-30 cm/sec. Riffles were used because they were the most important benthic habitat present at all study sites. The kicknet was placed immediately downstream from the riffle while the sampler used a hand to dislodge all attached benthic organisms from rocks upstream from the net. The organisms were swept by the current into the kicknet and subsequently transferred to a white pan. Each sample was examined in the field to assure that at least 100 organisms were collected at each site. In addition, each site was sampled for organisms in CPOM (coarse particulate organic matter, usually consisting of leaf packs from fast-current areas). All samples were preserved in the field with 70% ethanol.

Laboratory Analysis

In the laboratory, a 100 organism subsample was prepared from each site by evenly distributing the whole sample in a white, gridded pan. Grids were randomly selected and all organisms within grids were removed until 100 organisms had been selected from the entire sample.

Each animal was identified to the lowest practical taxon (usually genus or species). As each new taxon was identified. a representative specimen was preserved as a "voucher." All voucher specimens have been deposited in the Purdue University Department of Entomology collection.

RESULTS

Aquatic Habitat Analysis

When the Ohio EPA habitat scoring technique was used, the following aquatic habitat values were obtained for each site in the study:

	Score	% of Reference
Salt Creek (Site 1)	80	100
Little Laughery (Site 2)	63	79
Walnut Creek (Site 3)	53	66
Unnamed Tributary (Site 4)	72	90
Laughery Creek (Site 5)	85	106
Tub Creek (Site 6)	52	65

The maximum value obtainable by this scoring technique is 100, with higher values indicating better habitat. Sites with lower habitat values normally have lower biotic index values as well.

The scores indicate that the lowest habitat value in this study was at Site 6 (Tub Creek). Habitat at Site 6 was hampered by a paucity of stable bottom substrate and instream cover, by a very thin riparian buffer zone, and by moderately heavy bank erosion.

Water Quality Measurements
May 10, 1999

	D.O. mg/l	pH SU	Cond. uS	Temp. (C)
Site 1 (Salt Creek) Time = 11:15 a.m.	9.1	8.2	300	18.0
Site 2 (Little Laughery) Time = 12:30 p.m.	8.4	8.0	400	21.0
Site 3 (Walnut Creek) Time = 1:00 p.m.	9.3	8.3	400	23.0
Site 4 (Unnamed tributary) Time = 3:00 p.m.	9.8	8.4	300	23.5
Site 5 (Laughery Creek) Time = 2:15 p.m.	8.4	8.0	300	20.5
Site 6 (Tub Creek) Time = 1:45 p.m.	9.7	8.4	400	25.0

D.O. = Dissolved Oxygen
Cond. = Conductivity
Temp. = Temperature in Degrees Centigrade

Mussel Observations

No live mussels were observed at any of the sites. Site 5 on Laughery Creek contained numerous dead mussel shells (primarily Lampsilis siliquoidea), indicating that Upper Laughery Creek once contained a thriving mussel bed. No recently dead specimens were observed.

Table 1.
Rapid Bioassessment Results - Laughery Creek
May 1999

	Site #					
	1	2	3	4	5	6
Chironomidae (Midges)						
Cricotopus trifascia	12	24		20	10	28
Cricotopus bicinctus			1	2		4
Cardiocladius sp.	2					
Orthocladius obumbratus	12	9	4	6	15	5
Parametriocnemus sp.			1	4		8
Psectrocladius psilopterus	18	3	2	6	5	
Euorthocladius sp.	3	3	11		10	4
Eukiefferiella discoloripes						16
Tanytarsus sp.	9				2	
Polypedilum convictum	1			2		
P. illinoense			2			4
Thienemannymia gr.	3				2	
Ablabesmyia sp.			2	2		
Simuliidae (Blackflies)	18	54	58	26	11	10
Tipulidae (Craneflies)						
Antocha sp.				1		
Ephemeroptera (Mayflies)						
Stenonema tripunctatum					2	
Stenacron interpunctatum	2					
Heptagenia spp.					3	1
Baetis amplus					5	
Baetis flavistriga	1			13		
Trichoptera (Caddisflies)						
Cheumatopsyche spp.	6	1	2	3	2	
Hydropsyche betteni	2			1		
Helicopsyche borealis	2			1		
Plecoptera (Stoneflies)						
Amphinemura venosa	1	2		4	2	
Perlesta placida			1		9	1
Odonata (Dragonflies)						
Basiaeschna sp.		1			1	
Coleoptera (Beetles)						
Stenelmis crenata	1		3		2	
S. humerus				9		

Table 1 (continued)
Rapid Bioassessment Results - Laughery Creek
May 1999

	Site # 1	2	3	4	5	6
Isopoda (Pillbugs)						
Lirceus spp.			1			1
Amphipoda						
Hyalella azteca		1	11			18
Gastropoda (Snails)						
Elimia livescens					7	
Physella gyrina	3	1	1		2	
Pelycepoda (Clams)						
Pisidium sp.		1				
Turbellaria (Flatworms)	4					
Oligochaeta (Worms)						
Tubificidae					10	
Total	100	100	100	100	100	100

Table 2. Data Analysis for 5/99 Samples

METRICS

	Site # 1	2	3	4	5	6
# of Genera	18	11	14	14	17	11
Biotic Index	6.0	5.5	5.1	5.7	6.0	6.1
Scrapers/Filterers	0.8	0.4	0.1	1.0	1.9	3.3
EPT/Chironomids	0.3	0.1	0.1	0.5	0.5	0.03
% Dominant Taxon	18	27	29	26	16	28
EPT Index	7	2	2	5	6	2
Community Loss Index	0.0	0.9	0.6	0.5	0.4	1.2
% Shredders	1	2	1	4	1	0

SCORING

	Site # 1	2	3	4	5	6
# of Genera	6	4	4	4	6	4
Biotic Index	6	6	6	6	6	6
Scrapers/Filterers	6	6	0	6	6	6
EPT/Chironomids	6	4	4	6	6	0
% Dominant Taxon	6	4	4	4	6	4
EPT Index	6	0	0	4	6	0
Community Loss Index	6	4	4	6	6	4
% Shredders	6	6	6	6	6	0
TOTAL	48	34	28	42	48	24
% of Reference	100	71	58	88	100	50
Impairment Category	N	S	S	N	N	M

N = NONE S = SLIGHT M = MODERATE

DISCUSSION

Chemical parameters measured at each site indicate that dissolved oxygen (D.O.), pH, temperature, and conductivity fell within acceptable ranges for most forms of aquatic life.

A total of 31 macroinvertebrate genera were collected at the six sites. The most commonly collected invertebrates were midge and blackfly larvae. However, the pollution intolerant groups Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) were present at all sites.

Table 2 shows how the aquatic communities at the five study sites compared to that of the reference site. Site 5 (Laughery Creek) had a biotic index score equal to that of the reference. Site 4 (an unnamed tributary) also showed no impairment. Sites 2 and 3 (Little Laughery Creek and Walnut Fork) were "slightly impacted" while Site 6 (Tub Creek) was "moderately impacted." Impacted sites are shown graphically in Figure 3.

Figure 4 shows the normal relationship of biotic index scores to habitat values (a linear relationship according to [4]). The figure also shows a range of plus or minus 10% to account for a certain amount of measurement variability. When biotic index values fall outside this range, the site typically has degraded water quality. Figure 4 indicates that most of the study sites had biotic values within the range expected from its measured habitat value. Therefore, biotic values are dependent more on habitat degradation than on water quality. An exception occurs at Site 2 (Little Laughery Creek). This site may have slightly degraded water quality. The lack of EPT taxa at this site (only 3 individuals and 2 species) may indicate a temporary response to a toxicity-related episode.

Figure 3.
Degrees of Biological Impairment in Upper Laughery Creek

Green = No Impairment
Yellow = Slight Impairment
Orange = Moderate Impairment

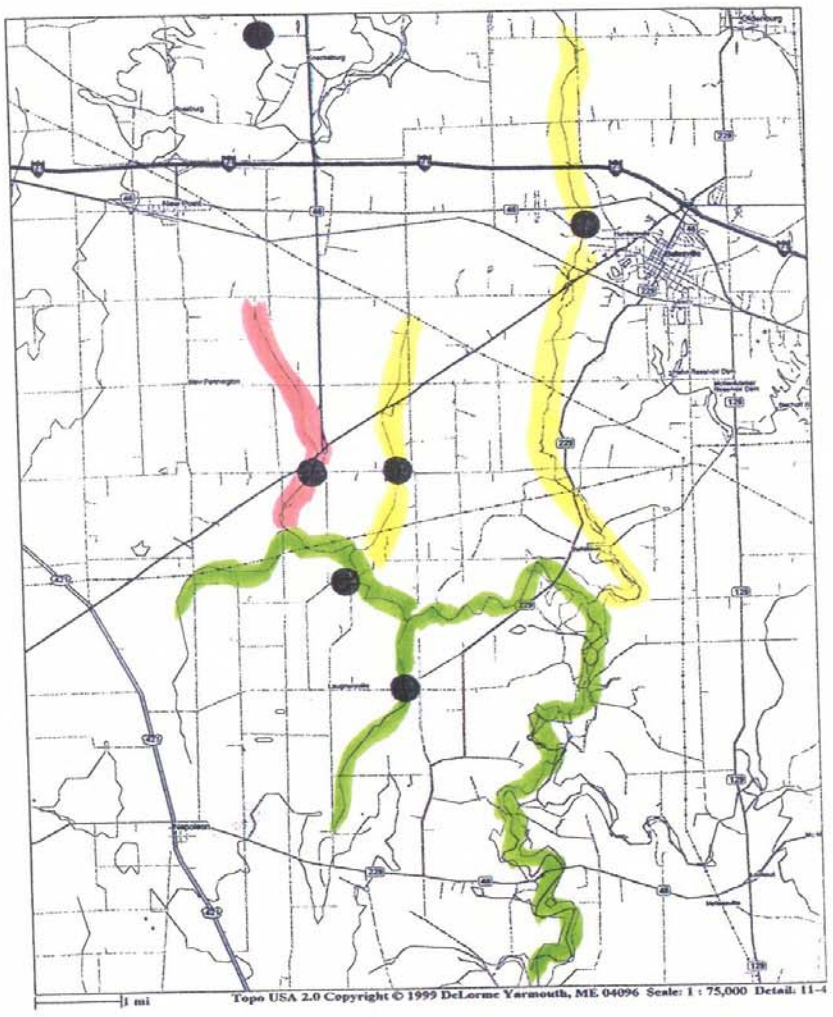


Figure 4.
Habitat vs. Biotic Index Scores

Sites falling outside the +10% range may be affected by degraded water quality

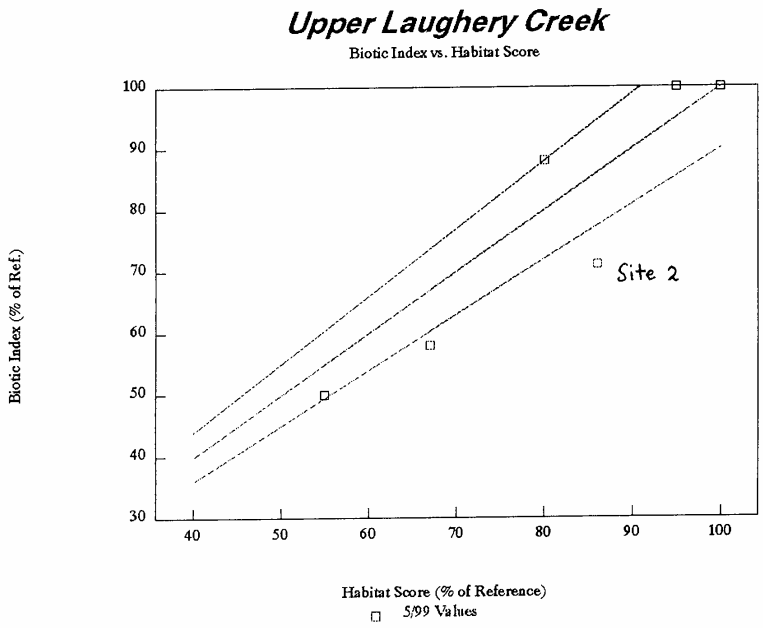


Table 4 shows sediment-tolerance values for many of the commonly collected animals in these streams. The proportion of sediment and turbidity-tolerant forms was lower at the study sites than at the reference site. Sediment intolerant forms were often more numerous at the study sites than at the reference site. These results indicate that sediment-related impairment is not a problem in the Upper Laughery Creek watershed.

Table 4. Sediment-Tolerant Species Observed
(Literature references to the species as an indicator are shown in brackets)

Cheumatopsyche sp.	[10] [9]
Hydropsyche betteni	[9]
Stenacron interpunctatum	[10]
Orthocladius spp.	[10] [16]
Thienemannymia group	[10]

% of Sediment-Tolerant Organisms at the Reference	Site 1	27%
% of Sediment-Tolerant Organisms at the Study Sites		
	Site 2	10%
	Site 3	8%
	Site 4	27%
	Site 5	18%
	Site 6	5%

Sediment-Intolerant Species Observed

Stenonema tripunctatum	[10] [15]
Plecoptera	[10]

% of Sediment-Intolerant Organisms at the Reference	Site 1	3%
% of Sediment-Intolerant Organisms at the Study Sites		
	Site 2	3%
	Site 3	12%
	Site 4	6%
	Site 5	8%
	Site 6	19%

Comparison to Previous Studies

The benthic macroinvertebrate community of Upper Laughery Creek was examined in 1994 [6]. The same sites were examined with the same bioassessment techniques, making it possible to make a reliable determination of changes during the intervening five year period. The changes are summarized below:

	7/94 Biotic Score	5/99 Biotic Score	7/94 Habitat Score	5/99 Habitat Score
Site 1 (reference)	100	100	100	100
Site 2 (L. Laughery)	76	71	86	79
Site 3 (Walnut)	57	58	67	66
Site 4 (tributary)	81	88	79	90
Site 5 (Laughery)	76	100	95	106
Average for Laughery watershed	72	79	82	85

Individual Metric Values for 1994 and (1999)

	Site Number 1	2	3	4	5
# of Genera	13 (18)	16 (11)	10 (14)	16 (14)	10 (17)
Biotic Index	5.2 (6.0)	5.8 (5.5)	5.5 (5.1)	5.3 (5.7)	7.3 (6.0)
Scrapers/Filt.	0.1 (0.8)	0.2 (0.4)	0.0 (0.1)	0.1 (1.0)	6.3 (1.9)
EPT/Chir	8 (0.3)	1.3 (0.1)	0.4 (0.1)	2.5 (0.5)	5.0 (0.5)
% Dominant	42 (18)	28 (27)	36 (29)	57 (26)	48 (16)
EPT Index	5 (7)	4 (2)	3 (2)	4 (5)	3 (6)
CLI Index	0.0 (0.0)	0.2 (0.9)	0.6 (0.6)	0.3 (0.5)	1.1 (0.4)
% Shredders	3 (2)	0 (2)	0 (1)	0 (4)	1 (1)

The average habitat score has increased by seven points since 1994. The average biotic index score has increased by three points. Some of the metrics (e.g. # of genera, the proportion of scrapers to filterers, the decline in dominance by a single group, and the percentage of shredders) have shown improvements at most sites since 1994. The largest improvement occurred at site 5, Laughery Creek downstream from Tub Creek and Walnut Fork. This biological community at this site has improved from "moderately degraded" to "no impact."

RECOMMENDATIONS

1. Work toward continued protection of the vegetative buffer zone along the stream corridors. Tree plantings along streams could be encouraged.

2. Discourage channelization of each stream. Minimizing channelization allows the streams to retain a natural channel that enhances aquatic habitat.

3. Discourage direct access to the streams by livestock. Large numbers of livestock can trample stream banks, decreasing the ability of streamside vegetation to filter out pollutants and hastening erosion.

4. Consider a bank stabilization program on some of the headwater streams. Concentrate efforts on the Tub Creek watershed.

5. Continue to monitoring these streams every 3 to 5 years to determine whether conditions continue to improve.

6. Continue to encourage volunteer monitoring in the watershed. Such programs provide invaluable educational opportunities and give participants a sense of ownership in the water quality improvements observed over the years.

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Habitat Scoring Results

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
SUBSTRATE	12	12	10	12	14	10
COVER	9	5	4	8	10	4
CHANNEL	13	10	7	12	15	8
RIPARIAN	15	7	7	13	13	7
POOL/RIFFLE	12	11	7	10	14	6
GRADIENT	10	10	10	10	10	10
DRAINAGE AREA	9	8	8	7	9	7
TOTAL	80	63	53	81	85	52

COMMONWEALTH BIOMONITORING
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BIOASSESSMENT SUMMARY
UPPER LAUGHERY CREEK

Purpose

To measure the water quality of Upper Laughery Creek by looking at the kinds of animals which live there. Has stream quality improved since runoff control (Project Clear) has been started?

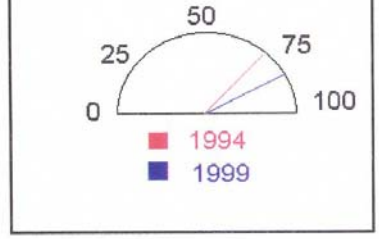
Watershed Characteristics

The watershed is predominantly agricultural but many Best Management Practices have been put in place since 1993 to reduce nutrient and sediment inputs.

Results

The aquatic community of Upper Laughery Creek has improved. Sediment intolerant forms of life had been rare but are now thriving in the watershed. Diversity has increased. Gravel stream bottoms are silt-free.

Water Quality Meter
A score of 100 is our goal



Definitions

Aquatic Habitat - physical characters which support life (shade, cover, stream bottom, food sources, etc.)

Biological Community - the kinds of animals living in a stream. High quality streams have many different kinds, including those intolerant to changes in habitat and water pollution.

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